(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 277 744 A2**

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88300619.9**

(51) Int. Cl.4: **G06K 11/06**

(22) Date of filing: **26.01.88**

(30) Priority: **02.02.87 GB 8702302**

(43) Date of publication of application:
10.08.88 Bulletin 88/32

(84) Designated Contracting States:
DE FR GB IT SE

(71) Applicant: **NATIONAL RESEARCH DEVELOPMENT CORPORATION**
101 Newington Causeway
London SE1 6BU(GB)

(72) Inventor: **Parks, John Ronald**
7 Gainsborough Road Ashley Heath
RingwoodSHampshire BH24 2HY(GB)

(74) Representative: **Hasler, Christopher**
Patent Department National Research Development Corporation 101 Newington Causeway
London SE1 6BU(GB)

(54) Method and apparatus for capturing information in drawing or writing.

(57) Where a signature is to be automatically verified, or data is to be entered into a computer, a special pen is usually employed but this pen is liable to be stolen or vandalised. In the present invention the tip 15 of an ordinary pen presses lined paper 12 on to a transparent plate 10 and modifies internal reflection in the plate at the point of contact. A light source 13 edge-illuminates the plate and light received by a receiver 14 at another edge of the plate varies in intensity as the pen tip crosses the lines. By measuring the intervals between crossing line boundaries information is obtained which can be analysed for use in signature verification and data entry.

EP 0 277 744 A2

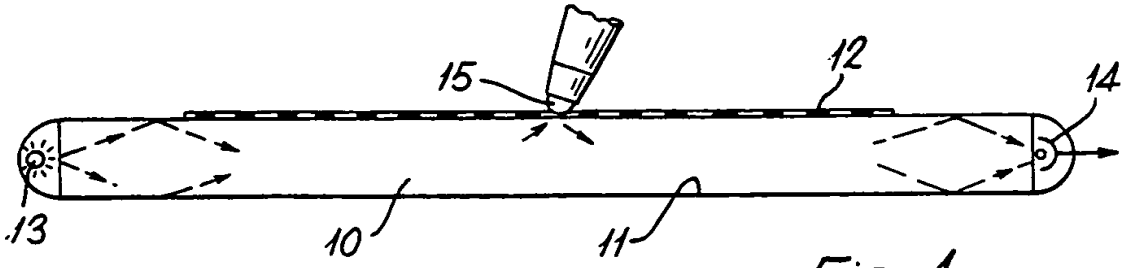

Fig. 1

METHOD AND APPARATUS FOR CAPTURING INFORMATION IN DRAWING OR WRITING

The present invention relates to methods and apparatus for generating signals as writing or drawing is carried out, the signals being dependent on the way in which the writing or drawing is carried out.

Signature verification methods are known in which the dynamic characteristics of the signature (characteristics obtained while the signature is being written) are used in signature verification. The present invention is expected to be particularly useful in such signature verification systems, these systems being of application to monetary transfers and data entry, for example.

A method and apparatus for generating signals as writing or drawing is carried out is described in British Application No. B626411 (PCT Application GB86/00681). However, the method and apparatus described in these earlier specifications usually relies on the use of a special pen which might be vandalised or stolen.

According to a first aspect of the present invention there is provided a method of obtaining information as writing or drawing is carried out, comprising the steps of

writing or drawing on a surface which is arranged to vary contact conditions at an interface between a flexible sheet and transparent (or translucent) material, using a tip of an instrument which contacts the surface, the interface having marks spread across a region where use of the writing instrument affects the said contact conditions,

supplying light to one side of the interface, and

sensing variations in light internally reflected at the interface, due to the presence of the marks, as contact conditions are changed by the tip when writing or drawing is being carried out.

An advantage of the method according to the present invention is that the drawing instrument may be a conventional pen or pencil and the remainder of the apparatus used may be fixed in place and is comparatively difficult to vandalise.

The method of the invention may also include temporal and/or spatial analysis of the mark crossings, for instance for signature verification or data capture. Some techniques are discussed in British Patent No. 1480066 and the above mentioned application.

The surface is usually the surface of a medium, such as paper, on which writing or drawing is carried out. This medium may form the flexible sheet, or the flexible sheet may be a transparent (or translucent) sheet, on which the medium is placed.

The marks are preferably parallel lines which need not be visible to the human eye so long as they are substantially opaque (or absorptive) to the light sensed. When a medium is used as the flexible sheet, the marks may be on the lower surface of the medium or, if the medium is reasonably translucent, on the upper surface thereof. An advantage is obtained if the marks are on the surface of the said material, or on the flexible sheet, where the sheet does not include the writing surface, since then ordinary unmarked paper can be used. The marks may be made using material which reradiates at a different wavelength from incident radiation, for example fluorescent or phosphorescent material. Such a change in wavelength is sometimes helpful in distinguishing between light from the lines and light supplied to the interior of the material.

The material may be in the form of a plate of transparent material such as glass, acrylic or transparent plastic material, with a source supplying light arranged along one or more edges of the plate, light variations being sensed along another edge or edges.

According to a second aspect of the present invention there is provided apparatus for use in obtaining information when writing or drawing is being carried out, comprising

a surface on which writing or drawing can be carried out or on which a medium for writing or drawing can be placed,

transparent (or translucent) material supporting the surface and having, in operation, an interface with a flexible sheet at which contact conditions in a region vary as writing or drawing takes place, the interface having marks spread across the said region,

means for supplying light to one side of the interface, and

means for sensing variations in the intensity of light internally reflected at the interface due to the presence of marks as the said contact conditions change when writing or drawing is carried out.

As mentioned above the said material may be in the form of a relatively thick edge-illuminated transparent plate. The means for sensing variations may include a light receiver positioned along an edge of the plate, or alternatively, the means for sensing variations may include a reflecting surface shaped to conform with the internal surface of any regular segment of a sphere. A light receiver is positioned to sense light within the part spherical surface which is preferably hemispherical, and the part spherical surface is positioned adjacent to the surface of the transparent (or translucent) material opposite the writing or drawing surface. With such an arrangement the positions of the light source

and the light receiver may be interchanged.

According to a third aspect of the present invention there is provided a method of obtaining information as writing or drawing is carried out, comprising the steps of

writing or drawing on a surface which is supported by transparent (or translucent) material using a tip of an instrument, marks being spread across the region where the writing instrument is to be used, and having the property of emitting light having a first wavelength when excited by light having a second wavelength, supplying light having the second wavelength to the said surface, and

sensing variations in light at the first wavelength due to the tip crossing the marks, as writing or drawing is carried out.

According to a fourth aspect of the present invention there is provided a method of obtaining information as writing or drawing is carried out, comprising the steps of

writing or drawing on a surface which is supported by transparent (or translucent) material using the tip of an instrument, the surface being marked by a set of parallel lines arranged in adjacent identical groups, with each group containing lines of at least three different thicknesses,

supplying light to the said surface,

sensing variations in light due to the tip crossing the lines as writing or drawing is carried out,

deriving signals representing the widths of the lines, and

employing the said signals to determine the direction of the component of the movement of the tip orthogonal to the lines.

To determine directions of movement components parallel to different axes, two sets of parallel lines each orthogonal to a respective axis may be used but each group in each set must then contain lines of at least four different thicknesses and the thicknesses must present different sequences in the different directions.

Preferably the lines of the, or each, set have substantially equally spaced axes.

The invention also includes apparatus corresponding to the method of the third and fourth aspects of the invention.

Certain embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a drawing showing a first embodiment of the invention employing a glass plate in which internal reflection takes place,

Figure 2 shows a second embodiment of the invention emp1oying an integrating hemisphere,

Figure 3a is a plan view of part of a third embodiment of the invention employing optical fibres to gather internally reflected light, and

Figure 3b is a side view of the third embodiment.

In Figure 1 a glass plate 10 is used as a support for documents such as the document 12 on which, for example, signatures are written. A 1ight source 13 is positioned along one edge of the plate 10 to inject 1ight into the plate where it trave1s by internal reflection to a light receiver 14, assuming that the plate 10 is supported in such a way that internal reflection at its lower surface 11 is not affected. If the surface 11 is mirrored to reflect light back into the plate 10 then the plate can be supported directly from below. As a pen is used to write a signature, a pressure of the order of several tonnes per square centimetre is exerted by a pen tip 15 and this pressure is transferred through the document to the supporting plate 10. Where this pressure reaches the plate it modifies the contact conditions between the document and the plate. Since internal reflection depends on density change across an interface a loose contact, which may amount to very little contact, and a contact applied with considerable pressure, allow different degrees of internal reflection. Where the contact is intimate the term 'optical contact' is used and there is a large difference in internal reflection relative to absence of contact. As shown the document has printed opaque or absorptive stripes or lines which when pressed into contact with the plate also modify the degree of internal reflection at the point where the tip 15 causes optical contact. Thus the light received by the receiver 14 is modulated each time a stripe or line is crossed and this information can be analysed in order to give temporal and spatial information about the signature written on the document.

An alternative arrangement is shown in Figure 2 where as before the glass plate 10 supports the document 12 on which signatures are written. Once again the document 12 contains opaque stripes or lines. The lower surface 20 of the plate has a mirrored surface except within a window 21 in which signatures are to be written. An integrating hemisphere 22 with an internal diffusely reflecting surface is positioned below the plate 10 and the mirrored surface 20 reflects light back into the hemisphere. An integrating sphere is a known optical device in which a sphere is internally coated with a diffusing coating so that any light introduced into the sphere is distributed uniformly over the whole internal surface. In fact any regular segment of a sphere can be used if the radial sides of the segment are formed of specular reflectors (i.e. mirrors). Thus an integrating hemisphere is a diametral cap closed with a mirror which then functions like a full sphere but is smaller. The window 21 in the diametral mirror 20 modifies this situation but only marginally.

Most of the light from the source 13 will be reflected internally within the plate 10 but some light is reflected through the window 21 due to the tip 15 bringing the document 12 into optical contact with the plate 10 and the consequent scattering of light at the point of contact. The amount of light passing out of the plate 10 through the window 21 depends on the nature of the document at the point where pressure is applied by the tip 15: that is whether it is transparent, opaque, absorptive or reflective. These variations are sensed by a light receiver positioned in the hemisphere 22 and indicate when the pen tip crosses a stripe or line. In an alternative to the arrangement of Figure 2 the positions of the light source 13 and the light receiver 24 may be interchanged.

The stripes or lines may be on the plate 10 instead of the document 12 in the arrangements of Figures 1 and 2.

In a third embodiment of the invention, "fish tails" 26 and 27 (see Figures 3a and 3b) made up of large numbers of optical fibres are joined at their wide ends along opposite sides of a transparent resin sheet 28. Each fibre is optically coupled into the edge of the sheet 28. At the narrow ends of the "fish tails", the fibres are assembled in bundles 29 and 30 and optically coupled to light receivers 32 and 33. The resin sheet can be cast between two glass plates (not shown) with the wide ends of the "fish tails" sandwiched between the plates but spaced apart to define a space for the resin. when the resin has hardened the glass plates are removed.

A transparent plastics or glass block 34 is located below the resin sheet 28 and preferably has mirrored surfaces to provide internal reflection except where adjacent to the sheet 28 and where a light source 35 is attached. Alternatively, the mirrored surfaces may be diffusely reflecting, for example white. In either arrangement operation is similar to Figure 2 since light in the block 34 can only enter or exit along the interface with the sheet 28 or through the aperture at the source 35. Thus the block 34 forms light-direction means directing light from the source 35 to the sheet 28. Several light sources may be located on any of the mirrored surfaces, each with its own aperture, to supplement the source 35.

In operation, a pen or stylus is used to sign, write or draw on a paper sheet 36 which is in loose contact with the sheet 28. Either the lower surface of the sheet 28 or the upper surface of the block 34 carry spaced apart lines which are preferably as widely spaced as they are thick.

When the pen or stylus applies pressure to the sheet 36, internal reflection at the interface between the block 34 and the sheet 28 is varied and light passing through the interface (unlike Figures 1 and 2) to the receivers 32 and 33 varies. Further, as the pen or stylus is moved over the paper sheet 36 and the lines are crossed, the light received by the light receivers is modulated.

An advantage of the arrangement of Figures 3a and 3b is that most extraneous light incident on the sheet 28 passes through to the block 34 instead of reaching the receivers 32 and 33. However the alternative can be used in which a light source is coupled to the optical fibres and a light receiver is coupled to the block 34. More than two "fish tails" can be used, for example further fish tails can be attached to the other sides of the sheet 28.

As mentioned above variations can be analysed to provide information relating to the nature of the signatures or other writing carried out on the document. For example, signals from the light receiver 14 or 24, or the receivers 32 or 33 may be passed to first and second threshold detectors (not shown) which determine, respectively, whether the signal received indicates that the tip of the pen or stylus is in contact with the paper, and whether the tip is in contact with the lines or the spaces between lines. Each time a boundary between a line and a space is crossed a counter (not shown) coupled to a clock circuit (not shown) is read out and then reset, under the control of the second threshold detector, to provide digital signals indicating the durations of the intervals in which the pen or stylus traverses lines and spaces. These intervals indicate the speed at which the pen or stylus crosses the paper but are also dependent on the direction of traverse and length of writing strokes. Thus the intervals are representative of the dynamic and spatial characteristics of a person's signature and also of individual data characters especially digits.

The durations of intervals for which the pen or stylus is out of contact with the paper are also indicated by another digital signal under the control of the first threshold detector. This digital signal is also useful in signature recognition and data recognition. Both digital signals are passed to a computer (not shown) which is programmed to carry out the analysis required. The techniques described in PCT Application GB 86/00681 and UK Patent Specification 1480066 are useful in this respect.

The light need not be visible to the human eye and therefore the lines or stripes on the document need not be visible although they must be substantially opaque to the light employed by the illuminating source. The lines or stripes may be in sets of parallel lines with an angle, usually preferably 90°, between lines in different sets. Alternatively the lines may be replaced by dots for example in an array with the dots at the vertices of regular polygons.

The pen used can usually be any conventional type, or a pencil or simply a stylus may be used. Analysis may be carried out as described in the above mentioned patent or application, the latter having an explanation of how lines in different groupings or colours can be used to indicate the position of the tip of a pen or its direction of traverse across a group of lines. For this purpose it may be necessary to use several differently coloured light sources in place of the source 13 or a single source with colours corresponding to the colours of different lines. A number of light receivers which are selectively responsible to the different colours are also required to replace the light receiver 14.

The amount of data captured as the pen moves can be increased by determining the direction of movement and an alternative method to that mentioned in the said application is now described. If the lines on the paper are parallel, have three different widths and are arranged in the order a,b,c,a,b,c .... etc. where a, b and c refer to line widths preferably with a > b > c, then components of movement in two opposite directions at right angles to the lines can be distinguished. With two orthogonal sets of parallel lines each having four different widths a, b, c and d then opposite directions of movement parallel to orthogonal axes can be distinguished. If line widths have the relationship a > b > c > d then the lines may have the sequence a, b, c, d, parallel to one axis and a,c,b,d parallel to the other axis. In general to distinguish two directions two widths in the sequence for one direction can be transposed to give the sequence for the other direction.

Where parallel lines of differing widths are employed it is useful if the axes of the lines are equally spaced, since then, if the pen or stylus tip moves in a straight line, the total time it is in contact with a space is equal to the total time it is in contact with a line. Another useful line arrangement which can be designed to have the same advantage, has corresponding line boundaries on one side of each line equally spaced while corresponding boundaries on the other sides are in selected modular positions giving the required line widths. Detection of movement is simplified and is determined by sensing, for example, whether all white to black boundaries are evenly spaced in time; if so then movement is in one direction, if not then it is in the other direction.

A technique for determining pen direction in one component direction is now described. A signal is derived which indicates when the edge of a line is crossed by the pen (for example by differentiating the signal from the light receiver) and when the pen movement has a component orthogonal to the lines in one direction the edge indications are spaced by intervals proportional to the thicknesses a,b,c,a,b, ... , respectively, as each line is crossed. A component of movement in the opposite direction gives intervals proportional to c,b,a,c,b,a. Thus by storing these intervals and comparing their magnitudes the direction of the said component of pen movement can be found. A microprocessor with read-only and random-access memory is easily programmed to carry out the process of storage and comparison but the process is usually only required after the pen may have changed direction. By detecting zero velocity in the said component, for example by determining when the differential of the line crossings per unit time falls to zero, likely times for direction changes can be found.

Claims

1. A method of obtaining information as writing or drawing is carried out, comprising

writing or drawing on a surface which is supported by transparent (or translucent) material, using a tip of an instrument which contacts the surface,

characterised in that writing or drawing on the surface varies contact conditions at an interface between a flexible sheet and the material, and the interface has marks spread across a region where use of the writing instrument affects the said contact conditions,

the method also being characterised by

supplying light to one side of the interface, and

sensing variations in light internally reflected at the interface, due to the presence of the marks, as contact conditions are changed by the tip when writing or drawing is being carried out.

2. A method according to Claim 1 characterised in that the marks include parallel lines or stripes.

3. A method according to Claim 1 or 2 characterised in that the light supplied to the interior of the material has a first wavelength,

the marks radiate light having a second wavelength when irradiated with light having the first wavelength, and

the light variations are sensed in light having the second wavelength.

4. A method according to Claim 1, 2 or 3 characterised in that the said surface is the surface of the said sheet and the marks are on the lower surface of the sheet or the upper surface of the said material.

5. A method according to Claim 1, 2 or 3 characterised in that the said surface is the surface of a medium placed on the said sheet and the sheet is transparent or translucent.

6. A method according to Claim 5 characterised in that the marks are on the lower surface of the sheet or the upper surface of the said material.

7. A method according to Claim 2, or any of Claims 3 to 6 insofar as dependent on Claim 2, characterised in that the lines or stripes have equally spaced centres and are arranged in adjacent identical groups with each group containing lines of at least three different thicknesses, and the method includes distinguishing components of movement of the tip orthogonal to the lines or stripes. 8. A method according to Claim 2, or any of Claims 3 to 6 insofar as dependent on Claim 2, characterised in that the lines or stripes are arranged in adjacent identical groups with each group containing lines of at least three different thicknesses, corresponding boundaries between lines or stripes are equally spaced on one side of all lines or stripes, and the method includes distinguishing components of movement of the tip orthogonal to the lines or stripes.

9. A method according to Claim 2, or any of Claims 3 to 8 insofar as dependent on Claim 2, characterised in that a plurality of sets of parallel lines or stripes are employed.

10. Apparatus for use in obtaining information when writing or drawing is being carried out, comprising

a surface on which writing or drawing can be carried out or on which a medium for writing or drawing can be placed,

transparent (or translucent) material supporting the surface,

characterised in that the material has, in operation, an interface with a flexible sheet at which contact conditions in a region vary as writing or drawing takes place, the interface having marks spread across the said region, and

in that the apparatus also comprises

means for supplying light to one side of the interface, and means for sensing variations in the intensity of light internally reflected at the interface due to the presence of marks as the said contact conditions change when writing or drawing is carried out.

11. Apparatus according to Claim 10 including the said medium wherein the medium forms the said flexible sheet and carries marks comprising parallel lines or stripes.

12. Apparatus according to Claim 10 including the said flexible sheet, wherein the lower surface of the sheet or the upper surface of the material carries marks comprising parallel lines or stripes.

13. Apparatus according to Claim 11 or 12 characterised in that the means for supplying light, in operation, supplies light having a first wavelength,

the marks comprise a substance which when irradiated with light of the first wavelength, radiates light having a second wavelength, and

the means for sensing light intensity variations is sensitive to light having the second wavelength.

I4. Apparatus according to any of Claims 10 to 13 wherein the said material is in the form of a plate, characterised in that the means for supplying light projects light into an edge of the plate, and/or the means for sensing light variations receives light from an edge of the p1ate.

15. Apparatus according to Claim 13 or 14 insofar as dependent on Claim 12, characterised by at least one group of optical fibres with one end of each fibre optically coupled to the said sheet along one edge thereof and the means for supplying light or the means for sensing variations optically coupled to the other ends of the fibres.

16. Apparatus according to any of Claims 10 to 15, wherein the said material is in the form of a plate, characterised by light-direction means arranged along that surface of the material which is opposite to the said surface and having other surfaces which are specular or diffuse reflecting surfaces, the means for supplying light or the means for sensing light variations being arranged to transmit light to, or receive light from, the light-direction means.

17. Apparatus according to any of Claims 10 to 15 wherein the said material is in the form of a plate, characterised in that the apparatus comprises a diffusing reflector shaped to conform with the interior of a regular segment of a sphere, the means for supplying light or the means for sensing light variations being positioned to transmit light to, or receive light from, the diffusing reflector, and the diffusing reflector being positioned adjacent to that face of the plate which is opposite to the said surface.

18. Apparatus according to Claim 17 characterised in that the regular segment is a hemisphere, and the said face of the plate is positioned across the open diameter of the hemisphere and forms a partial specular reflector reflecting light into the hemisphere.

19. Apparatus according to any of Claims 10 to 18 characterised in that the human eye is not sensitive to light supplied by the means for supplying light but the means for sensing light variations is sensitive to the light so supplied.

20. A method of obtaining information as writing or drawing is carried out, comprising

writing or drawing on a surface which is supported by transparent (or translucent) material using the tip of an instrument. the surface being marked by parallel lines, supplying light to the said surface, and

sensing variations in light due to the tip

crossing the lines as writing or drawing is carried out,

characterised in that the lines are arranged in adjacent identical groups, with each group containing lines of at least three different thicknesses, and by

deriving signals representing the thicknesses of the lines, and

employing the said signals to determine the direction of the component of the movement of the tip orthogonal to the lines.

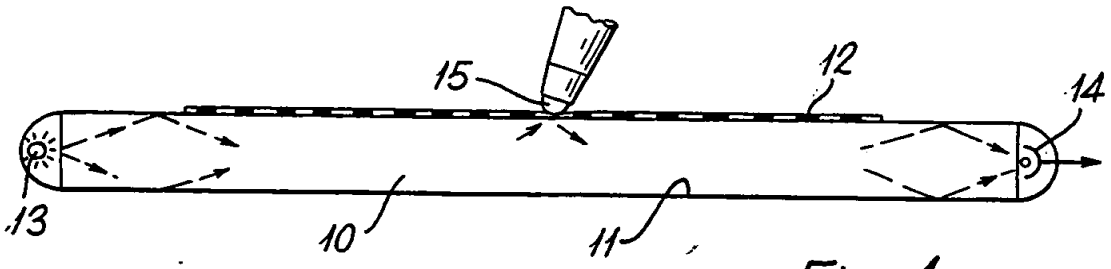

Fig. 1

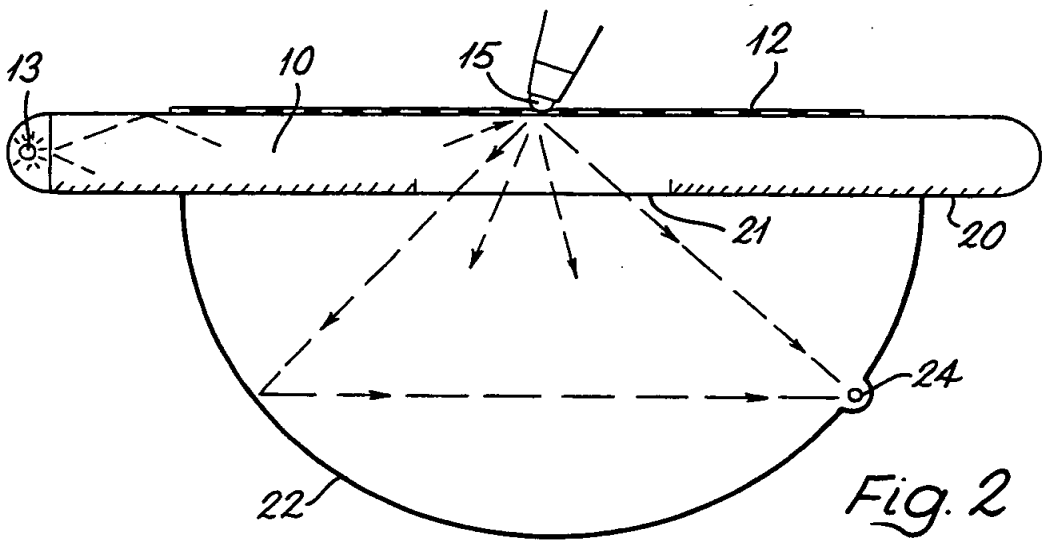

Fig. 2

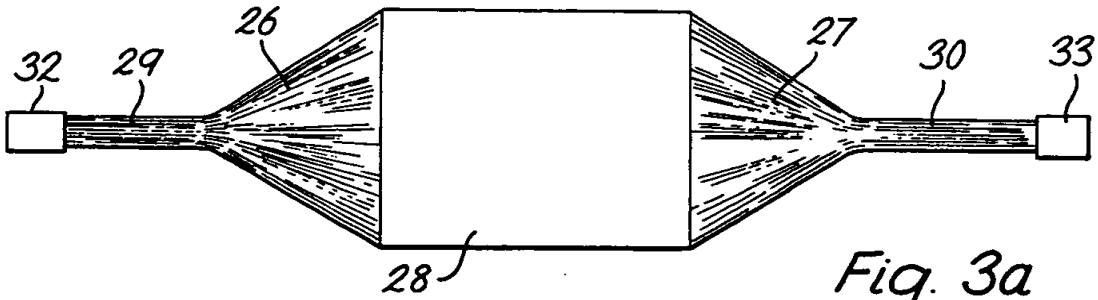

Fig. 3a

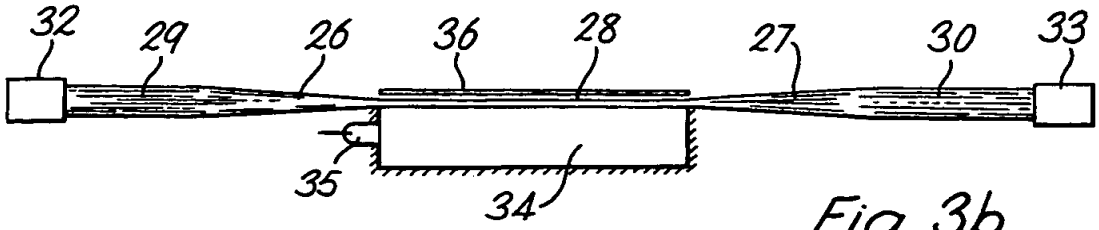

Fig. 3b